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AOARD REPORT

The Second International Conference on Thin Film Physics and Applications Held 15-17 April 94 at the Jin Sha Hotel in Shanghai, China

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- Trip Report -
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Abstract

The Second International Conference on Thin Film Physics and Applications was held 15-17 April 94 at the Jin Sha Hotel in Shanghai, China. The level of Chinese research carried out in thin film technology was found to be still immature as compared with the U.S., Japan, and Europe. Selected conference papers, presented by Chinese scientists, are included in this report to show the extent of research being carried in China in this field.

I. Introduction

The Second International Conference on Thin Film Physics and Applications was held 15-17 April 94 at the Jin Sha Hotel in Shanghai, China. The conference was sponsored by Chinese Physical Society and Shanghai Physical Society. There were 143 participants representing 12 different countries. Although there were 127 oral and 86 poster papers accepted altogether for the conference, the actual numbers of papers presented were less than 100 oral and 35 poster papers. The technical program consisted of 12 sessions, covering such areas as film structure, semiconductor and silicon films, optical films, surface and interface, compound semiconductors, optoelectronics films, superlattice and quantum well, dielectric and ferroelectric films, new technique of growth, superconducting films, M-O and diamond films, and organic and polymer films.

II. Observations

It was a bit of disappointment for me when the conference organizing committee did not inform the change in technical program on a timely manner to people who came to attend the conference. Because many changes were made in last minutes without much advance notices, some people had no idea of what paper was presented in which session until the last minute. In many occasions, people found out about changes after the session was opened. It was interesting to find out that one speaker did not even know when to give his talk because he was not notified of the change until he got to his session. One problem might be caused by unusually large numbers of last minute cancellations. It turned out that some sessions ended up with just a few papers. The worst one was the session on organic and polymer films where seven out nine papers were canceled. Also there was an incident where an invited paper was presented a day before the scheduled day without having most of the people knowing about the change. One possible reason was the language. The official language of the conference was English and it might have created some problems for Chinese organizers.

In the opening session, Prof. Shixun Zhou, chairman of the organizing committee, gave a short opening remark followed by five invited talks. Each invited talk lasted for 30 minutes. The five invited talks consisted of the following topics and speakers.

(1) "Fibonacci Sequence and Fibonacci Metallic Superlattice" by Prof. An Hu, Jinag, Laboratory of Solid State Microelectronics, Nanjing University, China;

(2) "Interface Control and Characterization of MOVPE Semiconductor Quantum Films" by Prof. M.H. Pilkuhn, Stuugart University, Germany;
(3) "Ion Beam Synthesis of Thin Films" by Prof. Shichang Zou, Ion Beam Laboratory, Shanghai Institute of Metallurgy, China;
(4) "Processing of Metal Oxide Thin Films From Liquid Precursors" by Prof. Relva C. Buchanan, Department of Materials Science and Engineering, University of Cincinnati, U.S.; and
(5) "Ferroelectric Thin Films and Their Applications" by Prof. W. Wersing, Siemens AAG, Corporate Research and Development, Munich, Germany.

The remaining 2 1/2 days were allocated for technical sessions with three sessions going on at the same time. The poster session was held in the evening of the second day for 3 hours. Unfortunately to say, more than 50 % of papers were canceled in the poster session. Even for those papers posted in the poster session, I only saw just a few people standing next to their papers willing to discuss their research work. I was dissapointed of the fact that I was not able to talk directly with Chinese scientists.

After listening to many of the Chinese papers presented in technical sessions, my personal feeling about this conference was that Chinese researchers used this forum to learn recent progress taken place in thin film technology from U.S., Japanese, and European scientists and also to establish better scientific communications for the future scientific endeavor by Chinese researchers in this field. The level of Chinese research in thin film technology was found considerably behind that of Japan, Europe, and the U.S. The extent of the current Chinese research activity being carried out in thin film technology at various Chinese research institutes can be best understood by reading some of the selected invited papers presented here. Selected are eight invited papers, including two aforementioned papers by Professors An Hu and Shichang Zou and six papers presented in technical sessions.

III. Abstracts of Selected Papers

The following are abstracts of selected papers by Chinese scientists.

1) The paper by Prof. An Hu et al, Laboratory o f Solid State Microstructures, Nanjing University, entitled "Fibonacci Sequence and Fibonacci Matallic Superlattice".

The quasi-periodic multilayer structures (Fibonacci sequence) have been studied both theoretically and experimentally. The quasi-periodic Nb/Cu, Cu/Ti, and Ta/Al metallic superlattices were fabricated by magnetron sputtering. The structures of superlattices were characterized by x-ray diffraction, electron diffraction, electron microscope, Auger spectroscopy and light scattering. The application of quasi-periodic mutilayers with high z and low z combination on x-ray optics is discussed. The theoretical idea and experimental realization of k-component Fibonecci superlattice are also presented and discussed.

2) The paper presented by Prof. Chichang Zou, Ion Beam Laboratory, Shanghai Institute of Metallurgy, Chinese Academy of Science, entitled "Ion Beam Synthesis of Thin Films".

The main research activities of thin film synthesis by ion beam techniques at Shanghai Institute of Metallurgy (SIM) are reviewed. Hard and metal alloy coatings such as TiN, TiBx, SiNx, DLC (diamond like carbon), Pt, and Ni/Cr-Ag are synthesized by ion beam

assisted deposition (IBAD) on different kinds of substrates at room temperature. The mechanical, electrical and the microstructureof thin films were systematically analyzed and discussed with the formation conditions. The experimental result reveals that one of the outstanding characteristics of the IBAD films is the very strong adhesion strength to the substrates. Also, the plasma immersion implantation (PSII) is used to synthesize thin TiN layer for the improvement of blood compatibility to the medical materials implanted in human body. Synthesizing film or buried layer by ion implantation is one of another newly developed technique. The formation of buried insulating layer in silicon crystal is carried out by high dose O^+ and N^+ implantation. Epitaxial growth of high Tc YBCO superconductive thin films on SrTiO is studied by DC magnetron sputtering, and the devices fabrication on it is developed. In addition, industrial application of above films or coatings is discussed.

3) The paper by Xun Wang, Surface Physics Laboratory and Fudan T.D. Lee Physics Laboratory, Fudan University, Shanghai, entitled "Recent Advances on Luminescence in Porous Silicon".

In this review article, we give a new insight into the luminescence mechanism of porous silicon. first, we observed a "pinning" characteristic of photoluminescence peeks for as-etched porous silicon samples. It was explained as resulting from the discontinuous variation of the size Si nanostructures, i.e. the size quantization. A tight-biding calculation of the energy band gap widening versus dimension of nanoscale Si based on the closed-shell Si cluster model agrees well with the experimental observations. Second, the blue light emission from porous silicon was achieved by using boiling water treatment. By investigating the luminescence micrographic images and the decaying behaviors of PL spectra, it has been shown that the blue light emission is believed to be originated from porous silicon skeleton rather than surface contamination. The conditions for achieving blue light need proper size if Si nanostructures, low surface recombination velocity and mechanically strong skeleton. The fulfillment of these emitting porous silicon is studied by using the temperature-dependent and picosecond time-resolved luminescence spectroscopy. A direct evidence of the existence of confined excitons induced by the quantum size effect has been revealed. Two excitation states are found to be responsible for the visible light emission., i.e. a higher lying energy state corresponding to the confined excitons in Si nanostructures and a lower lying energy state related with surfaces of Si wires or dots. A picture of the carrier transfer between the quantum confined state and the surface localized state has been proposed. Finally, we investigated the transient electroluminescence behaviors of Au/porous silicon/Si/Al structure and found it is very similar to that of an ordinary p-n junction light emitting diode. The mechanism of electroluminescence is explained as the carrier injection through the Au/porous silicon Schotky barrier and the porous silicon/p-Si heterojunction into the corrugated Si wires, where the radiative recombination of carriers occurs.

4) The paper by Yixin Chen, Shanghai Jiao Tong University, Shanghai, entitled "Non-Linear Optical Waveguides".

Optical waveguides are characterized by regions of high refractive index bounded by regions of lower index and they are ideal for optical nonlinear interactions. the key points are first the high power densities which are possible with moderate total powers due to

the beam confinement afforded by the small waveguide cross-sections. Second, the large intensities can be maintained over long propagation distances, the key to efficient nonlinear interactions. The implementation of nonlinear effects in waveguides has lead to the investigation and the application of many new effects unachievable in bulk media. In bulk media, to obtain in high intensities, it is usual necessary to focus laser beams. However, the tighter the focus, the shorter the distance over which it can be maintained.

In this paper I will discuss nonlinear optics in waveguides, materials and thin film technologies for non-linear optical waveguides, second and third order nonlinear waveguides and its device application. A lot of integrated optics devices have been developed over the last twenty years for various purposes as coupling, modulation, switching, etc. These devices rely either on wave vector matching between the coupled fields, or interference effect between two guided waves whose relative phase has been modulated externally. Essentially every such linear devices can be converted into non-linear devices by utilizing nonlinear materials in the waveguiding regions. In conclusion, non-linear optical waveguides have entered the technology phase. Perhaps this decade will also see commercial applications of nonlinear optical waveguides and nonlinear integrated optical in information processing, communication switching, and specialized computer tasks.

5) The paper by Guozhen Zhang et al, National Laboratory for Infrared Physics, Shanghai Institute of Technical Physics, Academia Sinica, Shanghai, entitled "Magnetoresistance Oscillation in Si Delta-Doping GaAs Multiple Quantum Well".

Using the MBE technique, we fabricated a GaAs film which contained three Si delta-doping layers, formed a three QW structure. Transverse magnetoresistance, longitudinal magnetoresistance and Hall resistance have been measured at low temperature from 0.3 K to 4.2 K and high magnetic field up to 7T. SdH oscillation of the transverse magnetoresistance and "diamagnetic" SdH oscillation of the longitudinal magnetoresistance have been observed. Based on the experimental results, mechanisms of the longitudinal oscillation and the Hall oscillation have been discussed. We also briefly analyzed the possibility of the magnetic induced metal-insulator transition.

6) The paper by Jinfa Tang et al, Department of Optical Engineering, Zhejiang University, Hangzhou, entitled "Photoconductive Films and the Applications in LCLV".

The effect of doping with copper and chlorine on various properties of vacuum-evaporated CdS and CdSe double layers has been studied. It was found that the dark conductivity decreases and the photoconductivity increases significantly if the ratio of Cu to Cl is suitable. The response time was about 510 ms for doping films and more than 100 ms for undoping ones. The liquid crystal light valves (LCLV), based on CdS-CdSe photoconductive films, used for visible and infrared, have been investigated, especially the switching ratio, contrast and response time.

7) The paper by Hong-Cheng Li, National Laboratory for Superconductivity, institute of Physics, Chinese Academy of Science, Beijing, entitled "Fabrication and Properties of High Temperature Superconducting Thin Films".

High temperature superconducting thin films of $GdBa_2Cu_3O_7$ (GBCO) were fabricated by dc-magnetron sputtering on $SrTiO_3$ $Zr(Y)O_2$ (YAZ), MgO, and $LaAlO_3$ (LAO) single

crystal substrates. The x-ray diffraction and TEM analysis showed the films were grown epitaxially with the c-axis perpendicular to the substrates surface. The rocking curve of the films were as narrowed as 0.4^{o} (FWHM). The zero resistance critical temperature of GBCO could be as high as 92K, and the critical current density at 77K and zero field are higher than 3 MA/cm^2.

8) The paper by Fuxi Gan, Shanghai Institute of Optics and Fine Mechanics, Academia Sinica, Shanghai, entitled "Physical Basis of Advanced Thin Films For Optical Disk Storage".

Since the optical disk storage was emerged, a great number of studies were performed concentrating on write, read and erase laser power, signal to noise ration, number of erase cycles, material fatigue etc. To further improve the optical recording performances and explore new optical storage media a lot of basic problems have to be solved. In this paper on the physical basis we discussed the physical property characteristics, structure and morphology of the films and written bit, phase transition at extra-unequilibrium condition, kinetics and transient changer of the structure and properties, as well as chemical and thermal stability of the optical storage media. Some our recent experimental results have been reported too, these allow us to better understand the mechanism and process of the optical recording.

To achieve high density and high data transfer rate of optical recording, it has to perform the optical recording at shorter laser wavelength and direct overwriting. New optical storage thin film both for magneto-optic and phase change types have been introduced. More attention has been paid on modulated multi-layer metallic films and rare-earth substituted iron garnet oxide films for magneto-optic recording, as well as inorganic chalcogenide and phthalocyanine organic thin films for phase change recording. On the physical basis the possibility of application of these new thin films has been analyzed.

IV. Concluding Remark

It seems that Chinese scientists have not reached the advanced level of Japanese, European, and U.S. scientists in thin film technology yet. They have many scientists working outside China and learning new techniques, especially in Japan and the U.S. At this conference, I saw many promising, young scientists who came back to their mother country to present their research work.

No new information was presented in this conference by both Chinese and non-Chinese scientists.